DOCUMENT RESUME

ED 206 453 SE 035 477

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TITLE Information Bulletins from the Calculator Information Center. Bulletins 8-11.
INSTITUTION Ohio State Univ., Columbus. Calculator Information Center.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE 81
CONTRACT 400-80-0007
NOTE 28p.: For related document, see ED 171 574.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Administrator Education; *Calculators; Educational Games; Educational Technology; *Elementary School Mathematics; Elementary Secondary Education; Instructional Materials; Learning Activities; Lesson Plans; *Mathematics Instruction; Parent Education; Problem Solving; *Secondary School Mathematics; *Teaching Methods

ABSTRACT

Four bulletins are presented, each addressing concerns that have arisen as teachers consider the use of calculators or begin to use calculators in their classrooms. Bulletin eight, prepared by Krist, begins with pragmatic suggestions and comments with regard to using calculators as an aid to student learning of secondary mathematics, and describes several learning activities. The ninth bulletin, by Lappan, starts with a letter to parents reagrding the benefits of calculators, and provides activities and educational games suitable for home use with pupils in grades 4-8. Bulletin ten, prepared by Thompson, provides 67 activities grouped into concept development, drill and practice, estimation, and problem solving, that can be completed in about ten minutes. Many can be developed into complete lessons. The eleventh bulletin, by Bestgen, provides 25 activities designed to aid in teaching computation with calculators at the elementary school level. (MP)

INFORMATION BULLETINS [illegible]
THE CALCULATOR INFORMATION CENTER

BULLETIN [illegible]

1980–1981

CALCULATOR
INFORMATION
CENTER

1200 Chambers Rd
Columbus, Ohio 43212

(614) 422-8503

Information Bulletin No. [illegible]
September [illegible]

USES OF CALCULATORS IN SECONDARY MATHEMATICS

Prepared by Betty J. Krist

Both scientific and programmable calculators can be used to advance mathematics learning in secondary schools. Before some activities are described, let us begin with some pragmatic suggestions and comments with regard to using calculators as an aid to student learning of secondary mathematics.

- For students and teachers who are working with calculators for the first time, it is easier to begin instruction when all the calculators are identical. However, when each student knows how to operate his or her particular calculator, the brand or variety of equipment is irrelevant.

- It takes students and teachers several days to become comfortable and confident in using a scientific calculator and several weeks to become adept at programming.

- It is easier and quicker to be wrong with a calculator than with paper and pencil alone. This apparent defect can be turned into an instructional asset. Remind students that they can easily and quickly check their work.

- Problems involving "messy" numbers rather than "neat" numbers are not necessarily appropriate merely because of calculator availability. "Messy" numbers may be as much a distraction with calculators as they are without them.

- Calculators are limited by the size of the display and the time available to perform a computation or run a program. Students should be encouraged to think beyond the calculator's parameters.

- The toy-like quality of a calculator invites students to involve themselves in independent intellectual "play" with the material being presented.

- Calculators may encourage students to believe that mathematics is arithmetic. Secondary students especially should be encouraged to think about mathematics beyond the numbers exhibited in a calculator's display.

- Calculators can allow us to deal with secondary mathematics in new ways. As you read the following brief descriptions of classroom activities, consider each as an example of a generic category where the calculator serves as an aid to instruction. If the specifics of the example do not fit your mathematics program, think of another content topic that could be substituted in the example.

USE CALCULATORS TO SUPPORT PROOF

Calculators can contribute to bridging the gap between formal proof and the understanding and acceptance of the basic theorem. Consider the following homework assignment:

Graph each of the functions (a) through (f) for $-2\pi \leq x \leq 2\pi$ and compare your results.

(a) $A(x) = \sin 2x$
(b) $B(x) = 2 \cdot \sin x$
(c) $C(x) = \sin^2 x$
(d) $D(x) = \sin x + \cos x$
(e) $E(x) = \sin x \cdot \cos x$
(f) $F(x) = 2 \cdot \sin x \cdot \cos x$

This assignment for beginning trig students is reasonable only with calculators having trig functions. Incorrect graphs are easily identified and corrected. Among the things that students can observe are that $\sin 2x \neq 2 \cdot \sin x$ because their graphs are different, but that $\sin 2x = 2 \cdot \sin x \cdot \cos x$ is a reasonable hypothesis because their graphs are the same.

The students can easily prove that $\sin 2x \neq 2 \sin x$ by a specific counterexample read from their graphs, but they cannot prove $\sin 2x = 2 \cdot \sin x \cdot \cos x$ by graphing alone. The teacher needs to provide a traditional proof, but the graphs have provided students with a simple and dramatic justification to support the proof.

USE CALCULATOR KEYS FOR INTRODUCING TOPICS

The class begins with a simple direction: "Your calculator has a key labeled $\boxed{\log}$. What does this key do?" One student is chosen to be the class secretary to write notes on the board. The students are encouraged to make conjectures that they can later support or refute. (Our own work with this activity has produced the rather startling initial conjecture -- within five minutes in three different instances -- that $10^{\log n} = n!$)

Students here are working on a detective story. They enjoy the clues given by their calculator and sense that the teacher would spoil their game if all their conjectures were answered as they arose. They can list many of the important properties of logarithms, some special cases, and some wrong statements. These can be the basis for class discussion as they are proved or disproved.

USE CALCULATORS FOR MAKING CONJECTURES

Another class begins with the teacher's statement, "I notice that $6^2 - 6 = 5^2 + 5$. What kind of mathematical curiosity is this?" The students can exhibit other instances of this same phenomenon and finally prove that $n^2 - n = (n - 1)^2 + (n - 1)$. They can appreciate the power of algebra and see its relation to arithmetic.

When dealing with number patterns, teachers must make special efforts to help students realize that a series of specific instances is far different from a mathematical proof. Questions like, "Is $n^2 + n + 17$ a prime number for any integer n?" help students cast a wry eye on their (and our) conjectures.

GO BEYOND RATIONAL NUMBERS WITH A CALCULATOR

Students can approximate π by the areas of successive regular polygons inscribed or circumscribed about a unit circle. Students can evaluate a finite number of terms of a Taylor Series to approximate specific values of trigonometric functions. Students can approximate e by evaluating $(1 + 1/n)^n$ for large n or by finding the sum of a finite number of terms of the series

$$\sum_{i=0}^{n} \frac{1}{i!}.$$

In each of these instances, students are dealing with rational approximations of irrational numbers.

Our students deserve an extensive appreciation of the entire complex number system. Let them graph the function $f(x) = x^x$. When $x > 0$, this function is well-behaved and easy to evaluate. When $x = 0$, students need to deal with a nonroutine mathematical question. (On different calculators $0^0 = 1$, or 0, or yields an error message.) When $x < 0$, the display can yield an error message or even a wrong result! (Most calculators in the present state of technology evaluate y^x by logarithms.) Now students must decide whether x^x is real or imaginary and what to do about it. This is a nonroutine and nontrivial dilemma that forces students to abandon their calculators in favor of pure thinking. Most transcendental functions yield equally dramatic questions, as do many sequences, series, and limits.

CAPITALIZE ON A CALCULATOR'S INADEQUACY

Ask students to decide whether the harmonic series and alternating harmonic series converge or diverge. Collect opinions and reasons. Divide the class into two sections. Ask one group to program their calculators to evaluate successive terms of the harmonic series, plug in their calculators, and run the program for several hours (or days), and then re-evaluate their opinions. Ask the other group to do the same for the alternating harmonic series.

Even if these programs ran forever, the results are inconclusive (for two reasons: the theoretical one and the finite display), but they suggest that the harmonic series diverges (a proof that teachers can provide by comparing sums of successive -- ever larger -- groups of terms with 1/2) and that the alternating harmonic series converges to ln 2 (a proof that teachers cannot provide without sophisticated techniques beyond secondary mathematics). The activity is exciting! The discussion can be lively and students get a glimpse of mathematics beyond algebra.

USE CALCULATORS AS THE ULTIMATE FUNCTION MACHINE

Program (or have the students program) 10 or 15 calculators so that a student need only enter a number (x) and initiate the program to evaluate f(x). Divide the students into teams. The game is to determine the function (or also its domain and range) that the calculator is executing to produce the final display. Some examples of programmed functions are polynomials; trigonometric, logarithmic, and exponential functions; 7 if x is an integer and 4 if x is not an integer; and the smallest prime factor. This activity is not only intellectually challenging, but it also gives students real insight into what these relations, functions, and procedures really are. After the game is over, the class can discuss what each calculator was programmed to do. One aspect of the class discussion could be centered around the similarities and differences between the functions that were programmed. This activity is very different from the standard type of question:

x	0	1	2	3	4
y	0	1	4	9	16

What is the relation between x and y?

Students can try whatever numbers they wish. They must also decide what additional numbers can give them new information. They must do and are allowed to do a lot more thinking than they needed to do to answer the standard restricted question.

USE CALCULATORS FOR GRAPHING

Have students plot 20 (or more) points of a particular function. This kind of activity can not only help students recognize the characteristic shapes of functions (even lines), but also can illuminate the relationship between sets of points and their equations. Students can even be introduced to other types of functions (rational, irrational) and other types of scales (full log, semi-log, polar) with ease. They can see many interesting and sophisticated aspects of mathematics in a short period of time.

THINK FOR YOURSELF

Each of these examples was generated by the serious consideration of ways to capitalize on calculator strengths and weaknesses. Each episode can be modified for other content topics or for other grade levels. You can probably generate at least one other example right now for yourself to use in your classroom. This mental exercise is one good way to invent calculator activities. Continue to ask yourself the question, "Can a calculator act as an aid at this time?" when you plan your lessons. Sometimes (maybe often) the answer is, "No!", but when the answer is "Yes" or even "Maybe", don't be

afraid to try. Activities such as these tend to be self-generating. Listen to your students' comments and follow your own curiosity.

Many very good examples have appeared (and will surely continue to appear) in journals such as the Mathematics Teacher, The Computing Teacher, and School Science and Mathematics. The NCTM has published a collection of articles (Burt, 1979) and the Calculator Information Center publishes extensive lists of articles that you may wish to consider (for a collection of the bulletins, see Suydam, 1979 a,b). The best ways to generate meaningful activities are (1) to read current literature, (2) to attend conferences, and (3) to keep your eyes and ears open in your own classroom. The specific references listed here are some that relate to the examples of this bulletin. They do not constitute an exhaustive bibliography.

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This information bulletin was written by Betty J. Krist, West Seneca Central Schools/ State University of New York at Buffalo.

The work upon which this publication is based was performed pursuant to Contract No. 400-80-0007 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.

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1200 Chambers Rd
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Information Bulletin No. 9
February 1981

Calculator Activities and Games to Play at Home: Grades 4 - 8

A Letter to Parents Prepared by Glenda Lappan

Dear Parents:

One remarkable by-product of the Space Industry is the miniaturization of electronic transistors and circuit boards. This technology has led to the production of inexpensive, reliable calculators, small and light enough to be carried in pockets or even worn on wrists. Over 80 million of these calculators have been sold in the United States since 1978.

In April 1980, the National Council of Teachers of Mathematics published An Agenda for Action: Recommendations for School Mathematics of the 1980s. The eight recommendations in the Agenda represent the careful analysis, by teachers and mathematics educators across the country, of the mathematical needs of children during the coming decade. One recommendation states:

> Mathematics programs must take full advantage of the power of calculators and computers at all grade levels.

To accomplish this recommendation, "All students should have access to calculators and increasingly to computers throughout their school mathematics program."

Most children will use calculational tools when they grow up, just as you may use them today. Therefore, it will help children to become comfortable with calculators during their school years. Did you know that calculators can also be used effectively to help children learn many ideas about numbers? It's true!

Many parents and teachers have asked, "What will happen to children's computational skills and achievement if they are allowed to use calculators?" Over 100 research studies on this question have been completed since 1975. The overwhelming evidence is that:

CALCULATORS HAVE NOT HARMED CHILDREN'S ACHIEVEMENT.

In all but a few of the studies, children using calculators scored as high or higher than children not using calculators, even though calculators were not used on tests.

In the 1980s we can turn our attention from checking the potential harm, to developing and testing innovative ways to use the calculator as a tool in the classroom. It can be used to help in teaching important mathematical skills and processes.

Using a calculator with your children at home can reinforce and extend the mathematics that is studied in school. Children benefit both from additional exposure to numbers and from parental support for studying mathematics. We hope you will use the calculator activities presented here to begin exploring ideas about numbers with your children. Free your imagination and curiosity and explore wherever your and your child's interest take you!

Many calculators have a built-in automatic constant function. If yours does, you can make up "rules" to hide in the machine for your child to discover. This gives children practice at basic facts in an enjoyable, problem-solving setting.

Suppose you want the calculator to take a number and give back that number plus 3. Prepare the calculator by keying in:

$\boxed{-}$ 3 $\boxed{+}$ 3 $\boxed{=}$. The display now reads "0" -- the rule is hidden.

> To find a clue about the hidden rule: PRESS 7 $\boxed{=}$. You will see 10.
>
> WITHOUT CLEARING, PRESS 8 $\boxed{=}$. You will see 11.
>
> Try some other numbers for clues.
>
> When you think you know the rule, enter a number and tell what the clue will be, then press $\boxed{=}$.

Other rules for calculators that "remember" the second number:

To prepare the rule "take away 7", key in 7 $\boxed{-}$ 7 $\boxed{=}$.

To prepare the rule "times 4", key in 0 $\boxed{x}$ 4 $\boxed{=}$.

To prepare the rule "divide by 2", key in 0 $\boxed{\div}$ 2 $\boxed{=}$.

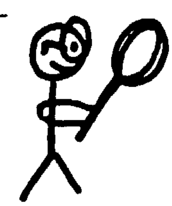
Some calculators "remember" the first number. If yours does, then key in:

3 $\boxed{-}$ 3 $\boxed{=}$ for a "+3" rule; 4 $\boxed{x}$ 0 $\boxed{=}$ for a "x4" rule; and so on.

When children ask what the $\boxed{x^2}$ and $\boxed{\sqrt{x}}$ keys on a calculator mean, answer by encouraging them to play "Guess My Rule" with the calculator. This builds readiness for the concepts in younger children and provides children in the middle grades with an opportunity to discover for themselves the meaning of each and the relationship between the two.

> The calculator has a secret rule named $\boxed{x^2}$.
>
> To find a clue about the rule: ENTER 2; PRESS $\boxed{x^2}$. You will see 4.
>
> Record the clue like this: $2 \longrightarrow 4$
>
> Ask the calculator for another clue. ENTER your number; PRESS $\boxed{x^2}$ and record the clue.
>
> When you think you know the rule, tell what the clue will be, and then PRESS $\boxed{x^2}$.

Once your child can correctly predict what $\boxed{x^2}$ will do, try this:



> Enter a number, PRESS $\boxed{x^2}$ and then $\boxed{\sqrt{x}}$.
>
> Example: ENTER 5; PRESS $\boxed{x^2}$; then PRESS $\boxed{\sqrt{x}}$.
>
> The DISPLAY shows 5, then 25, then 5 again.
>
> Try some more examples and "Guess My Rule".

With children in grades 7 and 8, try the keys in reverse order: PRESS $\boxed{\sqrt{x}}$ and then PRESS $\boxed{x^2}$.

AN ESTIMATION GAME Judging the reasonableness of an answer is an important skill which involves making quick mental estimates. The calculator is an excellent aid in developing such skills at all grade levels.

Take turns with your child posing a computational problem, estimating the answer, and checking with a calculator. Record the problem, the estimate, and the calculator answer. Explain the strategy used to estimate the answer, and together decide if the strategy was a good one.

Problem	Estimate	Computed Answer
23 x 46	about 1000	1058

Possible Strategy: 23 is near 20, so I'll round it down, but I'll round 46 up to 50: 20 x 50 = 1000.

This variation of a familiar game was developed by Mary Jane Winter and me:

Estimation BINGO (Multiplication)

48	799	39	364	589	304
944	208	1829	893	84	1652
496	752	476	272	247	51
1003	177	57	532	767	448
527	611	1121	93	1457	17 x 13 221
141	868	1316	403	323	2773

Each number on the grid is the product from multiplying two of these numbers:

3	59
31	17
16	19
47	13
28	

Rules for a two-person game:

- Pick two numbers, using estimation to choose numbers that might give you the box you want to fill when the two are multiplied.
- Use the calculator to multiply the two numbers.
- Mark the box with that product -- unless it is already taken! (Look at the example, 17 x 13 = 221.) Each player can use a different color pen to mark the box.
- The winner is the first to get 6 in a row, column, or diagonal -- a BINGO!

A Bingo grid also provides an interesting solitary activity. Try to get as many Bingo's as you can.

Calculator games are both fun and beneficial for children. They provide practice with numbers, computations, and logical thinking, to help children develop a "sense" for number. Here is a game that is most valuable when children write their own messages. Making up a problem with a particular answer requires good mathematical thinking.

Hidden Messages When some of the numerals on the calculator are viewed upside down, they can be read as letters of the alphabet. Here is a hidden message.

_____ (1) _____ (2) with _____ (3) as _____ (4) _____ (5) down the _____ (6)

on her _____ (7). _____ (8), no! The _____ (9) of her _____ (10)

went through _____ (11) _____ (12).

[Story written by Calc U. Lator]

Clues: Compute on a calculator and read the answer (upside down).

1. 89 $\boxed{+}$ 37 $\boxed{+}$ 22 $\boxed{+}$ 69 $\boxed{=}$
2. 10000000 $\boxed{-}$ 4623384 $\boxed{=}$
3. 4 $\boxed{\times}$ 4 $\boxed{\times}$ 211 $\boxed{=}$
4. 119025 $\boxed{\div}$ 5 $\boxed{\div}$ 3 $\boxed{\div}$ 23 $\boxed{=}$
5. 1379 $\boxed{+}$ 846 $\boxed{+}$ 428 $\boxed{=}$ $\boxed{\times}$ 2 $\boxed{=}$
6. 2 $\boxed{\times}$ 7 $\boxed{\times}$ 19 $\boxed{\times}$ 29 $\boxed{=}$
7. 1111111 $\boxed{-}$ 649736 $\boxed{=}$
8. 5 $\boxed{\times}$ 5328 $\boxed{\div}$ 666 $\boxed{=}$
9. 3 $\boxed{\times}$ 5 $\boxed{\times}$ 13 $\boxed{\times}$ 19 $\boxed{=}$
10. 9272025 $\boxed{\div}$ 3 $\boxed{\div}$ 5 $\boxed{\div}$ 7 $\boxed{\div}$ 29 $\boxed{=}$
11. .0101 $\boxed{\times}$ 8 $\boxed{+}$ 5 $\boxed{=}$
12. 157 $\boxed{+}$ 239 $\boxed{+}$ 365 $\boxed{=}$ $\boxed{\div}$ 10000 $\boxed{=}$

Using the upside-down symbols below, make up a word and then a problem to go with it.

1	2	3	4	5	6	7	8	9	0
I	Z	E	h	S	g	L	B		O

The hidden message in the box is:

Liz giggles with glee as she goes down the hill on her sleigh. Oh, no!
The sole of her shoe went through Bobo's igloo.

Arithmetic to Algebra

Calculators are excellent tools with which to investigate many ideas that lead from arithmetic to algebra. These activities are most appropriate for grades 7 and 8, but can be used to build readiness in grades 4, 5, and 6.

Compute 5 - 4 x 3, using a calculator.

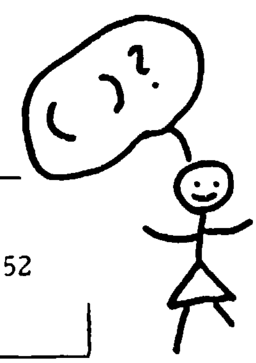
Did you get 3, or -7, as an answer? If your calculator subtracted first, you got 3; if the calculator multiplied first, you got -7! Clearly, we need to agree on which order to use. In mathematics, the standard order in which to do computations is: do what is in **parentheses** first, then do **multiplications and divisions**, and last do **additions and subtractions**. Therefore, we compute 5 - 4 x 3 by multiplying 4 x 3 first; then subtract the result, 12, from 5, so the answer is -7. If we want the subtraction to be done first, we must use parentheses: (5 - 4) x 3 = 1 x 3 = 3.

All calculators have a built-in logic; it will do 5 - 4 x 3 according to that logic, when we key in 5 $\boxed{-}$ 4 $\boxed{x}$ 3 . Our problem is to make the calculator do the problem the way we want. To make the calculator compute (5 - 4) x 3, we can key in 5 $\boxed{-}$ 4 $\boxed{=}$ $\boxed{x}$ 3 $\boxed{=}$: the answer will be 3. The extra $\boxed{=}$ forces the calculator to do 5 - 4 first.

To compute 5 - (4 x 3), we can always key in 4 $\boxed{x}$ 3 $\boxed{=}$ and write down the product, 12. Then key in 5 $\boxed{-}$ 12 $\boxed{=}$ to get -7. If your calculator has a memory, you can store the 12 and then key in 4 $\boxed{-}$ $\boxed{MR}$ $\boxed{=}$ where $\boxed{MR}$ stands for "memory recall".

Try these: (11 x 9) + 7 = ____ 11 x (9 + 7) = ____

Did you get 106 for the first and 176 for the second?



Insert parentheses to make these true:

16 x 15 - 7 = 233 16 x 15 - 7 = 128 16 x 15 + 7 = 352

16 x 15 + 7 = 247

Insert +, -, x, ÷, and parentheses, if needed, to make these true:

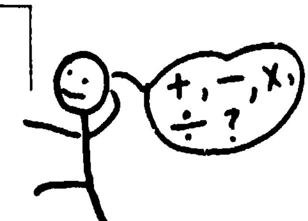
29 15 13 = 57	29 15 13 = 448	29 15 13 = 1
29 15 13 = 5655	29 15 13 = 58	29 15 13 = 422
29 15 13 = 0.1487179		29 15 13 = 182

Another interesting way to create a problem of this sort is to take the scores from a football or basketball game (write a one-digit score like 3 as 03). Put them together, and add +, -, x, ÷, and parentheses to make each number from 1 to 10.

Example: Michigan State 37, Ohio State 13

(3 + 7 - 1) ÷ 3 = 3

(3 x 7) - 13 = 8



An ancient game requiring logical thinking is called NIM.

1. Prepare the calculator by entering 21.
2. Two players alternate turns.
3. In turn, each player <u>must</u> subtract 1, 2, or 3 by pressing

   $\boxed{-}$ 1 $\boxed{=}$ or $\boxed{-}$ 2 $\boxed{=}$ or $\boxed{-}$ 3 $\boxed{=}$

4. The loser is the first player forced to leave zero or less in the display.

Here is an example of one game of NIM:

Player	Turn	Display	
		21	
1	$\boxed{-}$ 3 $\boxed{=}$	18	
2	$\boxed{-}$ 3 $\boxed{=}$	15	
1	$\boxed{-}$ 3 $\boxed{=}$	12	
2	$\boxed{-}$ 3 $\boxed{=}$	9	
1	$\boxed{-}$ 3 $\boxed{=}$	6	
2	$\boxed{-}$ 1 $\boxed{=}$	5	
1	$\boxed{-}$ 2 $\boxed{=}$	3	
2	$\boxed{-}$ 2 $\boxed{=}$	1	
1	$\boxed{-}$ 1 $\boxed{=}$	0	Player 1 loses!

This bulletin was prepared by Glenda Lappan, Michigan State University, East Lansing, Michigan.

The work upon which this publication is based was performed pursuant to Contract No. 400-80-0007 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.

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Information Bulletin No. 10
February 1981

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TEN-MINUTE CALCULATOR ACTIVITIES FOR GRADES 4-8

Prepared by Charles Thompson

We have all heard the incessant beep of electronic games in the toy department and have observed the three-year-old playing with the family calculator. If you wish to capitalize on children's inherent fascination with these gadgets and direct it toward increased mathematical learning, then the activities in this bulletin are for you. The activities will support and extend your ongoing instruction. Children who participate in these activities will not lose mathematical skill; on the contrary, these activities require that children use their existing knowledge of mathematics. In these activities, the calculator is used as a quick, unerring, and highly motivational tool to help children learn important mathematical skills.

The activities are grouped into four major categories:

(1) concept development,

(2) drill and practice,

(3) estimation, and

(4) problem solving.

Each activity can be completed in about ten minutes, and many can be developed into complete lessons. The activities are for children in grades 4 through 8. Often an activity that is appropriate for fourth grade can be made suitable for sixth or eighth grade simply by using fractions or decimals in place of whole numbers.

Frequently, activities involving addition or subtraction can be modified slightly to use multiplication or division. Many activities are adaptable to any size of group, depending on the number of calculators available. Thus, if a limited number of calculators is available, these activities could be printed on cards and placed with the calculators in a corner of the room for children to use in groups of one or two.

Some of the activities are especially suitable for a calculator with a constant. These calculators count or multiply repeatedly by pressing the $\boxed{=}$ key. For example, if 8 $\boxed{+}$ 6 $\boxed{=}$ $\boxed{=}$ $\boxed{=}$ is entered into a calculator with a constant, the calculator adds 6 to the displayed number each time the $\boxed{=}$ is pressed. Activities that are especially suitable for calculators with a constant are marked with a *.

Happy calculating!

CONCEPT DEVELOPMENT ACTIVITIES

* **Counting**: Have children predict how long
1 it would take to make their calculators count to 1000 by 1's. Then try it. How long if they count by 1's? 5's? 10's?

* **Multiplies**: Pick a number, say 42, and ask
2 children to determine which numbers added repeatedly will total exactly 42. 1 will, 2 will, 3 will. What about 4? Relate results to multiplication and division facts and to the concepts of factors and multiples.

Fact families: Let children use a calculator
3 to find 16 x 7 = ☐. Then without the calculator solve 16 x ☐ = 112, 112 ÷ 7 = ☐ and 112 = 7 x ☐. Check these with a calculator.

Multiplying by 5: Have children use a
4 calculator to multiply several one-, two-, and three-digit numbers by 5. Have them write down the answers and look at the ones place in each answer. See if they can discover that "a number is a multiple of 5 (divisible by 5) if the ones digit is 0 or 5."

Multiplying and dividing by 10: Have
5 children enter a 7 on a calculator and divide by 10. Divide by 10 again, again. Note the movement of the decimal point. At some stage, say 0.007, multiply by 10. Multiply by 10 again. Repeat. Note what happens to the decimal point. Have children verbalize a rule about the movement of the decimal point when a number is multiplied by 10 (divided by 10).

Multiplying by 10's: Since 7 x 8 = 56,
6 have children use a calculator to find 7 x 80, 7 x 800, and then predict 7 x 8000 and 7 x 80 000. Check with a calculator.

Square roots: Give children a large
7 number that is a perfect square and have them use their calculators to find what number times itself equals the given number (e.g., ☐ x ☐ = 255 025).

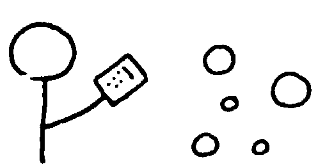
Square roots: Give children one- or two-
8 digit numbers and have them use a calculator to find the square roots -- accurate to two decimal places (e.g., ☐ x ☐ = 5). Also try ☐ x ☐ x ☐ = 14.

Square roots: Have children use a cal-
9 culator to find $\sqrt{256}$ and $\sqrt{2.56}$; $\sqrt{625}$ and $\sqrt{6.25}$. Look for patterns. Now find $\sqrt{576}$ and predict $\sqrt{5.76}$. Check.

* **Doubling**: Ask children if they would
10 rather receive an allowance of \$5 a week for 4 months or an allowance of 1¢ the first week, 2¢ the second, 4¢ the third, 8¢ the fourth week, and so on, for four months. How much allowance would each method provide on the 16th week?

Pythagorean theorem: Provide children with drawings of several different
11 right triangles with sides labeled a, b, and c in each one (c is the longest side). Have them measure the lengths of a, b, and c in each triangle and calculate a^2, b^2, c^2, and $a^2 + b^2$. See if they can discover that $a^2 + b^2 = c^2$ in each triangle.

Geometry: Give children drawings of
12 ten circles. Have them measure the diameter and circumference for each circle and calculate c ÷ d. Generalize about c ÷ d for any circle and compare students' results for c ÷ d with the decimal representation of π.



Addition/multiplication: Have a child
13 determine how to use a calculator to solve computations that involve numbers that are apparently too big (e.g., for 34 713 914 + 78 392 404 = □, add 34 million and 78 million separately). Also try 76 000 x 800 000 = □ (multiply 76 000 x 8; then mentally multiply the result by 100 000).

Remainders: Have children use a cal-
14 culator to find remainders for division problems. For example, find 16 ÷ 6, 45 ÷ 6. (Suggested method: 45 ÷ 6 = 7.5, so the remainder is 0.5 x 6 = 3. Or, 45 - (7 x 6) = 3.)

Decimal fractions: Have children use a calculator to determine decimal forms for
15 fractions like 3/10, 8/100, and 47/100 by dividing. Locate the decimal forms on a number line. Then find the decimals for 1/4, 1/3, 3/8, and locate these on a number line. Ultimately have children compare fractions by comparing their decimal forms.

Decimal fractions: Ask children to find
16 the decimals for 1/111, 2/111, 3/111, and then to predict 5/111, 9/111. Check with a calculator.

Repeating decimals: Have children find the
17 decimal for for 26/99 and 78/99. Then have them predict 51/99 and check with a calculator.

* **Counting by tenths**: "Pretend the calculator
18 is the car's odometer and make it count by 0.1 for each tenth of a kilometer that you travel. Watch what happens. What number comes after 0.9? After 1.9? Your car has gone 5.7 kilometers (enter 5.7 on your calculator). It goes five-tenths of a kilometer farther. What will the calculator show then?"

Negative numbers: Provide children
19 with an unmarked drawing of a thermometer having 20 temperature divisions. Have them label the top mark 10° and enter 10 in their calculators. Then have them subtract 1 repeatedly -- 20 times -- and record the resulting numbers on their thermometers. Then pose problems like, "If the temperature was 2° and dropped 5° more, what would the resulting temperature be?"

DRILL AND PRACTICE ACTIVITIES

Addition: First player enters 1, 2, 3,
20 4, 5, or 6 on the calculator, followed by a $\boxed{+}$. Second player does the same. Play continues with players taking turns. Player to make the calculator display exactly 50 is the winner.

Addition: First player enters any one-digit number. Second player adds
21 any number on the calculator adjacent to the number just entered. For example, if 6 is entered, then only 3, 2, 5, 8, or 9 may be added by the next player. Play continues according to the rule described above until one player makes exactly 31. Any player exceeding 31 loses.

Number words: Write number words on
22 an overhead projector and have students display the numbers on a calculator.

Number names: Say a number orally for
23 children to display on their calculators (e.g., "three hundred thousand sixty-two"; "twenty and twenty-one hundredths").

Place value: One child enters a number
24 in the calculator (e.g., 26.48), hands it to another player, and asks him or her to change a certain digit (e.g, 4) to 0 by subtracting some number (e.g., 26.48 - 0.4 = 26.08).

25 **Multiplication facts**: Have a child enter a one-digit number (e.g., 9) then [x], then [=]. This locks 9 in the calculator, and any number subsequently entered will be multiplied by 9 if [=] is pressed. Give the child a random list of numbers (0-9) and have him or her write the products of those numbers with 9. Then enter each of the numbers (0-9) in the calculator, followed by [=], to check the answers.

26 **Magic squares**: Every row, column, and diagonal has the same sum. Have children complete this magic square:

154	77	
99		
110		88

27 **Inverse relationships**: Have children use a calculator to complete a multiplication (or addition) table:

x		14	
37	925		
59			3599
		588	

28 **Inverse operations**: One player selects a two-digit number and performs a series of operations (known to both players) and then hands the calculator to the other player. The second player tries to determine what number the first player selected. Example:
▨ ▨ [+] 10 [−] 12 [x] 2 [=] 48

29 **Addition**: What two-digit number when added to the number formed by reversing the two digits gives an answer closest to 50? Is there more than one answer?

30 * **Basic facts**: Pose this problem for children: Use only the 4, [+], [−], [x], [÷], [=] keys to make the calculator display 7. What is the fewest number of moves required? Try for other numbers 1-10. (One solution: 44 [÷] 4 [−] 4 [=] 7.)

31 **Addition/multiplication** ("The Price Is Right"): Show children a page from a catalog containing items of interest. Establish a target, say $50, and challenge the children to see which one of them can select a set of items with a combined cost closest to (but not exceeding) $50. Permit children to select no more than three of any one item.

32 **Basic facts** ("Who's Closer?"): Each player writes down a secret two-digit number. Then, one player covers the display while each player secretly enters a one-digit number followed by a [+] into the calculator. The resulting random number is revealed to all players. Then the first player calls out a one-digit number. The second player performs any operation (+, −, x, ÷) with the called number and the one on display. The second player then calls out a one-digit number and the next player performs any operation with the number called and the one on display. At any time any player may call "Freeze" and the game ends. Whoever's secret number is closest to the number on display wins.

33 **Addition/subtraction** ("Plus or Minus"): Player 1 enters a two-digit number on the calculator and passes it to Player 2. Player 1 then calls out a new two-digit number. Player 2 must add (or subtract) a one- or two-digit number to (from) the one showing to make the new number called -- within 10 seconds. Whether or not Player 2 obtains the new number within 10 seconds, he or she must pass the calculator to the next player and call out a new two-digit number to be made within 10 seconds. Play continues until only one player remains. A player drops out when he or she fails to make the number called within 10 seconds.

Addition/subtraction: Ask several
34 children to write down any three-digit number they wish (with no two digits the same) and then to use the same digits in reverse order to form another three-digit number. Have them each use a calculator to subtract the smaller from the larger. Then, ask them to take their result and add it to the three-digit number formed by reversing the digits of the result. Ask each what he or she got. It should be 1089. Have them try this several times to see if it always works.

Fractions/decimals: Two children play
35 on a 4 x 4 grid. In each square a fraction has been written. The first player selects a fraction and each player enters into his or her calculator an estimate of the decimal form of that fraction. Then each player multiplies that decimal by the denominator of the selected fraction. The player having the product closest to the numerator of the selected fraction puts his or her marker on that fraction. Then the second player selects a fraction to estimate. Play continues until all fractions are covered. The player who has covered the most fractions wins.

* **Problem**: How many years would it take
36 to double an investment of \$2000 at 13.5% compounded annually? What if it is compounded quarterly (that is, at $13.5 \div 4 = 3.375\%$ every three months)? (Answers: 6 years, 5.25 years.)

Problem: How old are you in years?
37 Months? Weeks? Days? Hours? Minutes? Seconds?

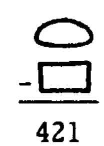
ESTIMATION ACTIVITIES

Column addition: Give a child a set of
38 column addition exercises, each involving 4 two-, three-, or four-digit addends. Below each exercise write the sum of any three of the addends. The child's task is to determine which of the addends is not used. (Example: 268 + 127 + 395 + 461 = 924.)

Addition: A range is established,
39 say 105-110, and a number is given to a child (e.g., 48). The child must choose a corresponding number so that its sum, with 48, is within the established range. A calculator is used to check sums. If the sum is within the range, the child scores 1 point. Play in pairs. The first player to get 5 points wins.

Addition: Present children with a set
40 of addition problems that have missing digits among the addends (e.g., 1■5 + ■15 + 714 = 1054). Use the calculator to find the missing digits.

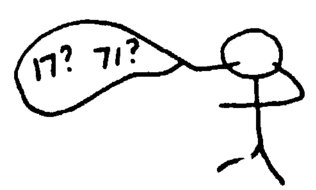
Subtraction: Give the child a series of
41 subtraction problems written in this form:



Also give the child a set of possible top numbers and a set of possible bottom numbers. The child's task is to use the calculator to construct correct problems within a fixed time limit. Be sure that not all combinations of top numbers and bottom numbers give differences that are listed.

Multiples of 10: Give a child a set of
42 number sentences like $n \times 7 < 387$. The child is to estimate the largest multiples of 10 (10, 20, 30, ... 90) that will make the inequalities correct. Then the child uses the calculator to check estimations.

Computation: Present sets of three
43 arithmetic expressions (e.g., 83 x 45, 72 x 51, 65 x 65) and have students select the largest and smallest by estimating. Use a calculator to check.



Multiplication: Give the child a 6 x 6 grid of numbers and a list of nine other
44 two-digit numbers. (The grid of numbers is created by forming all possible products from the list of nine numbers [factors].) The child selects any two of the factors, computes the product on a calculator, locates the product on the grid, and writes the two factors below the product. The goal is to determine within 9 tries the factors of six products that form a straight line on the grid -- horizontally, vertically, or diagonally.

Rounding/addition ("Grocery Shopping"): Use a grocery advertisement and ask
45 children to select 10 items to buy. Have them write the cost of each item and also a rounded (estimated) price. Then have them mentally determine an estimated total price by using the rounded prices. Compare this to the actual total cost determined by using a calculator.

Division: Set a quotient range, say 7-10,
46 and select a start number to enter into the calculator, say 55. The child's task is to divide 55 by some number so that the result is between 7 and 10. If the child does so on the first try, he or she gets a point. See if the child can get five in a row correct.

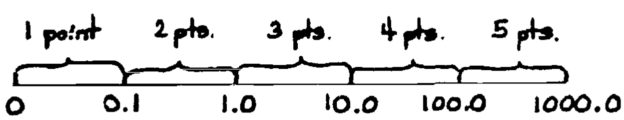
* **Division** ("The Big One"): The first player enters a secret three-digit number
47 and presses $\boxed{-}$ $\boxed{=}$. This displays a 1 on the calculator, since the calculator has performed n ÷ n. The second player enters his or her guess of the secret number, say x, and presses $\boxed{=}$. Since the calculator calculates x ÷ n, it gives information about the closeness of the guess to the secret number. Specifically, if the guess x was less than n, then the calculator display will be less than 1, since $x \div n < n \div n$. Likewise, too large a guess will result in a display greater than 1. The second player continues entering numbers, each followed by $\boxed{=}$, until he or she finds the secret number n. Then the number of guesses is counted. The roles are reversed and the first player tries to guess the second player's secret number in fewer guesses.

Decimals: Give students a sheet of
48 number sentences involving decimals, but in each number sentence circle one of the numbers and omit the decimal point. Students insert the decimal point and check with a calculator. (Example: 1.872 ÷ 234 = 0.8.)

Multiplication with decimals: Two players
49 agree on an answer range (e.g., 650-700). The first player enters a number and pushes $\boxed{\times}$. The second player does the same. Play continues in this manner until one player gets within the specified range and is declared the winner.

Mental arithmetic: Give the child pairs of
50 arithmetical expressions and have him or her estimate which expression in each pair is larger. The child inserts the appropriate symbol <, >, or = and checks the estimate by using the calculator. (Example: 775 - 5 ☐ 775 - 0.5.)

Multiplying decimals: Provide a child
51 with a list of about 20 decimal numbers ranging from about 0.01 to 30.0. The child circles any two numbers and uses a calculator to determine the product. Depending on the size of the product, the child receives points according to the following scale:



The goal is to score 15 points by making six or fewer products.

PROBLEM SOLVING ACTIVITIES

* **Sequences**: Have children use a calculator
52 with a constant to continue these sequences:

9, 13, 17, __, __, __

57, 51, 45, __, __, __

3, 9, 27, __, __, __

11, 22, 44, __, __, __

64, 32, 16, __, __, __

53 **Addition**: The child is given a menu from a fast-food restaurant and the total costs of four lunches. The child is also told the number of items ordered for each lunch. The child is to determine the items that compose each lunch.

54 **Addition/subtraction** ("Back to Front"): Give each student a random three-digit number, say 194. This number is entered in the calculator. The students mentally reverse this number and write down the result (491). The new number becomes the goal for the game. The students must get from the first number (194) to the second (491) by adding (in this case) or subtracting two-digit numbers. Only one operation, addition or subtraction, may be used in each game. The two-digit numbers that are added or subtracted are limited to those that can be created from the digits currently displayed on the calculator. For example, beginning with 194, 49 may be added, since both 4 and 9 are displayed -- yielding 194 + 49 = 243. Then 32 could be added, and so forth. The student who comes closest to the target number is the winner.

55 **Installment buying**: Pose this problem to students: "A stereo advertised for $99.95 can be purchased for $20 down and $7.95 a month for 12 months. How much does the stereo cost when purchased on the installment plan?"

56 **Unit pricing**: Have children use a calculator to determine which of several sizes of an item would be the best buy.

57 **Multiples**: "I can't remember whether I put 558 or 585 marbles in a jar. But I do know that each time I put in a red marble, I also put in 5 blue marbles. How many marbles are in the jar?"

58 **Squaring numbers**: Have children use a calculator to calculate 15 x 15, 25 x 25, 35 x 35, 45 x 45, 55 x 55, 65 x 65. Have them look for patterns and predict 75 x 75. Use a calculator to check.

59 **Multiplying 99**: Have children multiply three two-digit numbers by 99 and look for patterns. Have them predict 99 x 64 = ☐ and 99 x 70 = ☐ and then check.

60 **Patterns**: Have children solve these problems on a calculator and find a pattern: 11 x 11, 111 x 111, 1111 x 1111. Predict 11111 x 11111 and then check.

61 **Multiplying 9's**: Have children use a calculator to find the pattern in 9 x 9, 99 x 99, 999 x 999, 9 999 x 9 999, and then predict 999 999 x 999 999.

62 * **Multiplication**: A superball bounces 0.9 of the height from which it falls. Thus, a ball dropped from a height of 100 cm will initially bounce to a height of 90 cm. To what height will it bounce after it strikes the floor the fifth time? The tenth time? (Answers: 59 cm, 35 cm.)

63 * **Multiplication**: Ask children this problem: "Suppose the inflation rate of 13% were to continue for the next ten years. What would be the cost in ten years of a 25¢ candy bar? A $1 hamburger? A $6 000 car?" (Answers: 85¢, $3.39, $ 20 367.)

64 **Problem**: Present children with a price list of party refreshments and a $30 limit. They are to use a calculator to select the items to buy for ten people.

65 **Averages**: Ask children to use the calculator to estimate the number of words in a book. You might suggest finding the average number of words by counting the words on several pages.

66 **Problem**: If all the people in the U.S. (230 000 000) stood in a line, how long would the line be? Would it stretch across your state? Across the U.S.? (Answer: about 87 000 miles.)

67 **Problem**: Fourteen 70-foot long railroad cars pass through a railroad crossing in one minute. What is the speed of the train in miles per hour? (Answer: 11.1 mph.)

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[Many additional sources are listed on Reference Bulletins available from the Calculator Information Center.]

This bulletin was prepared by Charles Thompson, University of Louisville, Louisville, Kentucky.

The work upon which this publication is based was performed pursuant to Contract No. 400-80-0007 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.

CALCULATOR INFORMATION CENTER

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Information Bulletin No. 11
August 1981

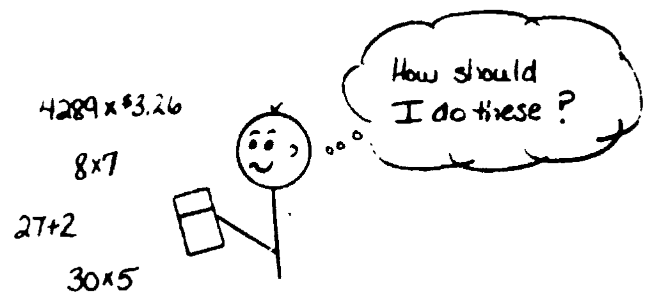
25 Activities for Teaching Computation with Calculators

Prepared by Barbara J. Bestgen

Our elementary mathematics curriculum is slowly beginning to change, reflecting the influence of an ever-increasing supply of calculators. However, one area of focus has not changed:

The need to know basic facts and simple computation techniques is as important as ever.

As teachers, we need to recognize this need and help children establish these important skills. We must also help them recognize when and where calculator use is appropriate and when quick recall, concept knowledge, and mental computation are more efficient tools than calculators. The issue is not whether to use calculators or paper/pencil computation -- children should be encouraged to use each as appropriate tools. Careful guidance is important in reaching this goal.



Many materials are currently available to help incorporate meaningful use of the calculator into mathematics instruction. This bulletin is yet another source of information and ideas to get the most use from your calculator. It is specifically aimed at providing a source of ideas to help develop and anchor basic facts and paper/pencil computation skills. While many ideas are suggested, you are encouraged to experiment and explore ideas which these suggestions may trigger in your own thinking.

The only sure way to memorize the basic facts is through practice -- and variety is the key. Provided here are a collection of practice activities which use the calculator as an aid in checking answers, collecting information, and discovering patterns.

Find the Shortcut. Ask students to do these problems using their calculators. Discuss the answers -- can we find a simpler (quicker) way to do these?

$$\begin{array}{r} 148 \\ 148 \\ 148 \\ 148 \\ +\ 148 \\ \hline ? \end{array}$$

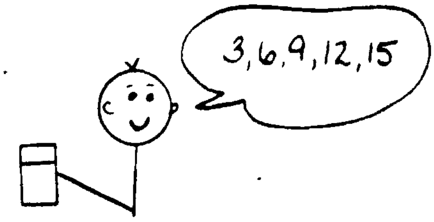
$7 + 7 + 7 + 7 = ?$

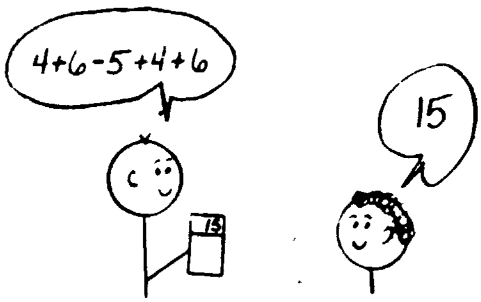
$a + a + a + a + a = 45$ (find a)

$5 \times 5 \times 5 \times 5 \times 5 \times 5 = ?$

Count on Your Calculator.

If your calculator has a constant addend capability, use it to let students practice skip counting by numbers. This activity provides valuable readiness for learning the concept of multiplication as well as the products associated with different tables.





Beat the Calculator.

To practice basic facts, one student orally gives another student a chain of facts using only certain numbers and operations. The first student uses the calculator as the chain is given, while the second student computes the answer mentally. For example:

Use only +, −, and the numbers 4, 5, 6.

Complete the Math Sentence.

For a quick practice idea to be used when you have a few minutes, allow the students to use the calculator to try this:

Using only the numbers 8, 7, 5 complete each of these sentences:

___ + ___ = 15	56 ÷ ___ = ___
___ + ___ + ___ = 23	___ x ___ + ___ = 47
___ x ___ = 40	

Find the Missing Operations.

Ask students to use +, −, x, ÷ or = to fill in the ○'s to make a correct math sentence. The calculator can be used to try out and verify possibilities.

4 ○ 8 ○ 12

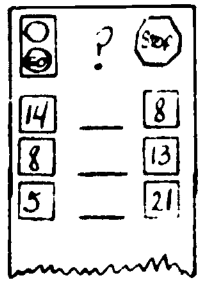
6 ○ 8 ○ 0.75

8 ○ 5 ○ 2 ○ 26

.
.
.

Which Operations Were Used?

One person names 3 numbers (for example 4, 8, and 10) and secretly uses them in a math sentence of his or her choosing. For example, 4 x 8 + 10 = 42. The first player tells the second player the results, 42. It is the second player's job to determine which operations were used on the 3 numbers to produce the result of 42.



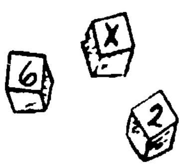
Can You Get It? The student is given a number to start with, a calculator, and a finish number. It's up to the student to decide how to get the finish number. For example, if you start at 8, what can be done? How can it be done with one move? (-6) two moves? with only multiplication and subtraction?

What's My Number? If your calculator has the constant addend feature, try this: hide a number and an operation by this method (or whatever method works on your calculator): Press 4 + =. Now, ask the child to enter any number, then =. Do this for several pairs of numbers as you form a table of values.

Number entered	Calculator display
7	11
9	13
4	8
.	
.	.
.	.

The student continues until the child spots and names the rule (+4).

How Fast Are You? Each student needs a calculator and there should be a leader (the teacher or a member of the class). The leader presents a series of simple computations orally, one at a time. Students work them on their calculators. As soon as a correct answer is given, the leader reads the next problem and so on. This exercise encourages students to think quickly and to use the most efficient tool for the task, whether the calculator or their memory.



Mental Computation Game. Prepare 3 dice in this manner: first with numerals 1 to 6; second with numerals 4 to 9; third labeled +, +, -, -, x, x. Two or more students take turns rolling the set of dice and mentally computing the resulting math sentence. If correct, the answer is the student's score for that round and should be kept as a running sum on that student's calculator -- first to ~~200~~ wins!

Even or Odd Problem. The student enters a number less than 20 into the calculator. If the number is even, divide the displayed number by 2. If it is odd, multiply by 3 and add 1. Look at the new number - follow the same rules:

if even ----- divide by 2
if odd ------ multiply by 3 and add 1

Continue in this manner until the display shows 1. You will want to consider several questions:

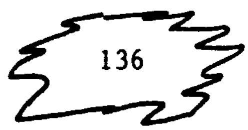
Will all numbers less than 20 eventually reach 1?

Which number less than 20 will take the longest to reach 1?
Do even numbers reach 1 more quickly than odd numbers?

How Many Equations Can You Write? Give the student a small amount of time (say 1 minute) and a calculator to write as many equations as possible to produce the number 28. The only rule is that each expression must contain the digit 2 at least once. For example, some solutions would be:

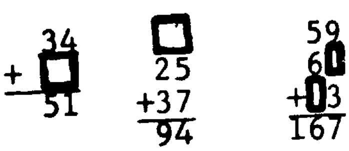
2 + 26   2 x 14   2 x 7 x 2   . . .

Multiplication Contest. The student is given a number and is asked to write as many multiplication sentences which have this product as he or she can with help of a calculator. For example,



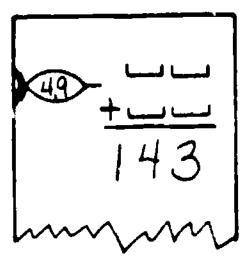
2 x 68
4 x 34
2 x 2 x 34
⋮

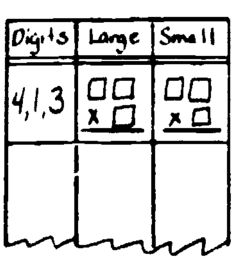
An important aspect of learning to use paper/pencil computation algorithms is understanding how, why, and when tney work. Focusing attention on number patterns, estimation, and the effect of certain operations on the relative size of numbers are some ways to approach real understanding of what's happening. Provided here are suggestions looking at these ideas as well as others.



Missing Digit Problems. Give problems such as those illustrated here to be done with the help of a calculator. Problems such as this require students to think about and use the standard paper/pencil algorithm.

Target Addition. Using only the digits indicated on the dart, complete the problem to get the sum 143. Is there more than one way to do it?





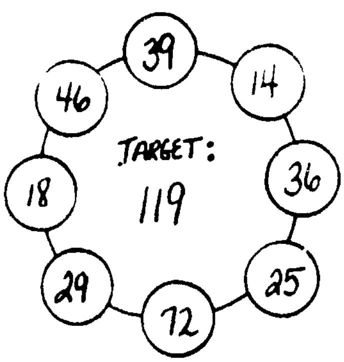
Largest/Smallest. Using only the digits indicated, fill them in tne boxes to find the largest and smallest possible products. When trying for a large product, where should the biggest digits be placed? Why? How about when trying for a small product?

What Did She Buy? This activity will help encourage students to use estimation and to consider patterns in numbers as they search for an answer.

Brooke bought 3 items from the menu and paid $1.47 -- What did she buy?

MENU

Big Burger	79¢
Lil Burger	64¢
Big Fries	49¢
Lil Fries	34¢
Big Pop	39¢
Lil Pop	24¢



Estimating Sums. Try this idea for encouraging students to estimate sums and to use number patterns:

Draw a loop around any 3 digit adjacent numbers which add to the target number.

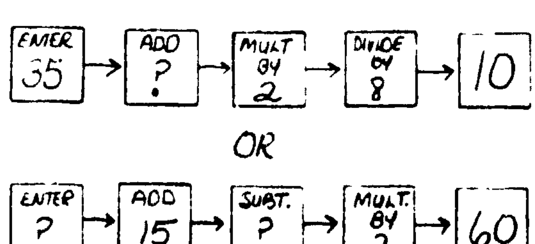
Calculation Puzzle. Have students try puzzles of this sort using their calculators:

I entered a start number into my calculator, divided it by 25, subtracted 17, and multiplied by 54. My answer was 1242. What was my start number?

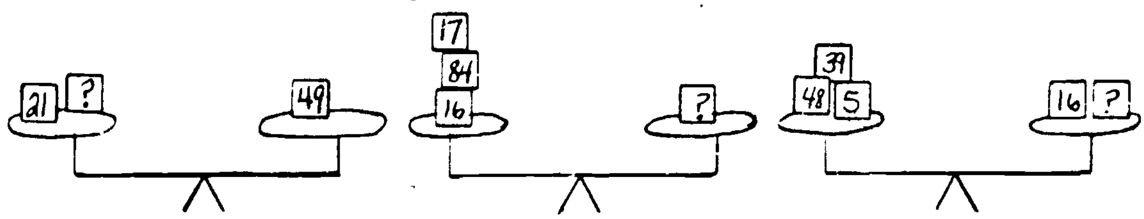
Ask them to make puzzles of this sort for a friend to try.

Find the Missing Number. To provide a problem solving experience which focuses on inverse operations, try this:

Ask the student to find the missing number using the calculator.



Add or Subtract Problems. Problems such as this help students think about the importance and use of both addition and subtraction operations.



Find the missing weights of the boxes.

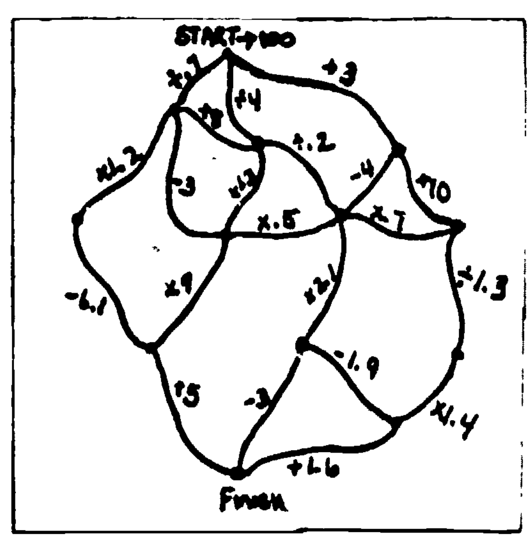
Get to 1. To help students see the effect of adding, subtracting, multiplying, and dividing a number by another number, try this:

> Give the student a start number, for example 986. The student must reduce the number to 1 in four moves by adding, subtracting, multiplying, or dividing it by whatever numbers they choose. For example, here is one solution:

Start	Move	Result
986	-900	86
	÷2	43
	-40	3
	÷3	1

Vary the activity by requiring the student to use each operation once and only once.

Which Path? To explore the effects of performing addition, subtraction, multiplication, and division on decimal numbers, try this:



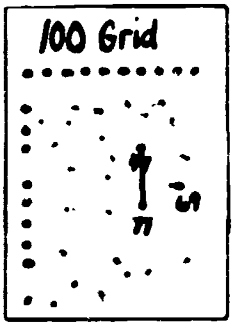
> Students use a maze such as this. Starting with the number 100, they decide what path to take to get to the finish line. As they travel, they must enter the appropriate numbers and operations into the calculator. The goal is to produce the largest (or smallest) number at the finish line. Only lateral and/or downward movements are allowed.

Even or Odd Game. To focus on the effects of arithmetic operations in producing odd or even numbers, try this:

> Each of two players decides who will be even and who will be odd. The game begins by entering 10 into the calculator. Players take turns entering an operation (+, -, x, or ÷) of their choosing, a 1-digit number, and the equal sign. Each number can be used only once (be sure to keep track of used numbers).
>
> If division produces a decimal number, round it to the nearest whole number. When all 1-digit numbers have been used, the even player wins if the display is even, the odd player wins if the display is odd.

Spinning the Web. To practice both estimation and mental computation, try this:

> This is a game for two players or 2 teams of players - one is a spider and one is the fly. The spider and fly start somewhere on the 100 grid other than 1 or 100. For example, on this grid the spider tries to capture the fly by spinning a web around it, but cannot directly run into the fly. The fly simply tries to avoid being trapped (not having a move to make). Each player takes turns moving by estimating what to add or subtract from or to the number they are on. The calculator is then used to perform the calculation. For example, on this grid the spider started at 47 and decided to add 30 to get to 77. The fly can now estimate what to add to 69 or subtract from it to make its move. But, if the fly's move requires it to pass through the web (the fly only flies in straight lines), it is caught and the game is over. A limit should be placed on how many moves the spider can have to trap the fly (this depends on the level, but 8-10 moves is about right for fourth graders.)



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The work upon which this publication is based was performed pursuant to Contract No. 400-80-0007 of the National Institute of Education. It does not, however, necessarily reflect the views of that agency.